

I CLAIM:

1. In a fuel cell comprising an anode electrode, a cathode electrode and a proton exchange membrane electrolyte disposed therebetween, the improvement comprising:

an anode catalyst layer disposed on one of an electrolyte facing surface of said anode electrode and an anode electrode facing surface of said electrolyte, said anode catalyst layer comprising a proton conductive material and an electron conductive material substantially uniformly dispersed throughout said catalyst layer.

2. A fuel cell in accordance with Claim 1, wherein said proton conductive material comprises a derivative of an acid selected from the group consisting of sulfuric acid, phosphoric acid and mixtures thereof.

3. A fuel cell in accordance with Claim 2, wherein said derivative is selected from the group consisting of sulfonates, phosphonates, sulfonic acids, phosphonic acids and mixtures thereof.

4. A fuel cell in accordance with Claim 3, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

5. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises at least one electropolymerized ionomer.

6. A fuel cell in accordance with Claim 5, wherein said ionomer is selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

7. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises an ionomer selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

8. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises a grafted polymer.

9. A fuel cell in accordance with Claim 8, wherein said grafted polymer comprises polyaniline grafted to lignin.

10. A fuel cell in accordance with Claim 1, wherein said electron conductive material is grafted with a proton conductive material.

11. A fuel cell in accordance with Claim 1, wherein said electron conductive material is at least one of sulfonated and phosphonated.

12. A fuel cell in accordance with Claim 1, wherein said proton exchange membrane electrolyte has a thickness of less than about 4 mils

13. A fuel cell in accordance with Claim 1, wherein said anode catalyst layer comprises a PtRu catalyst material in an amount of less than about 5 mg/cm<sup>2</sup>.

14. A fuel cell in accordance with Claim 1, wherein said electron conductive material comprises in a range of about 5% by weight to about 20% by weight of said anode catalyst layer.

15. An electrode comprising:  
a gas diffusion layer; and  
an anode catalyst layer disposed on one surface of said gas diffusion layer, said anode catalyst layer comprising a plurality of catalyst particles and a catalyst particle binder, said catalyst particle binder comprising at least one proton conductive material and at least one electron conductive material.

16. An electrode in accordance with Claim 15, wherein said proton conductive material comprises a derivative of an acid selected from the group consisting of sulfuric acid, phosphoric acid and mixtures thereof.

17. An electrode in accordance with Claim 16, wherein said derivative is selected from the group consisting of sulfonates, phosphonates, sulfonic acids, phosphonic acids and mixtures thereof.

18. An electrode in accordance with Claim 16, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

19. An electrode in accordance with Claim 15, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

20. A method for producing a fuel cell electrode comprising the steps of:

mixing a plurality of anode catalyst particles with a binder material, said binder material comprising an electron conductive material and a proton conductive material, forming a proton-conductive and electron-conductive anode catalyst ink; and

applying said proton-conductive and electron-conductive anode catalyst ink to an anode electrode gas diffusion layer, forming a fuel cell anode electrode.

21. A method in accordance with Claim 20, wherein said proton

conductive material comprises a derivative of an acid selected from the group consisting of sulfuric acid, phosphoric acid and mixtures thereof.

22. A method in accordance with Claim 21, wherein said derivative is selected from the group consisting of sulfonates, phosphonates, sulfonic acids, phosphonic acids and mixtures thereof.

23. A method in accordance with Claim 22, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

24. A method in accordance with Claim 20, wherein said electron conductive material comprises at least one electropolymerized ionomer.

25. A method in accordance with Claim 23, wherein said ionomer is selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

26. A method in accordance with Claim 20, wherein said electron conductive material comprises a grafted polymer.

27. A method in accordance with Claim 26, wherein said grafted

polymer comprises polyaniline grafted to lignin.

28. A method in accordance with Claim 26, wherein said electron conductive material is grafted with a proton conductive material.

29. A method in accordance with Claim 20, wherein said electron conductive material is at least one of sulfonated and phosphonated.

30. In a direct methanol fuel cell comprising an anode electrode, a cathode electrode and a proton exchange membrane electrolyte disposed therebetween, a method for one of reducing and substantially eliminating methanol crossover from said anode electrode to said cathode electrode, the method comprising the steps of:

applying a catalyst ink comprising an electron conductive material and a proton conductive material to one of an electrolyte facing surface of said anode electrode and an anode electrode facing surface of said proton exchange membrane electrolyte.

31. A method in accordance with Claim 30, wherein said proton conductive material comprises a derivative of an acid selected from the group consisting of sulfuric acid, phosphoric acid and mixtures thereof.

32. A method in accordance with Claim 31, wherein said derivative is selected from the group consisting of sulfonates, phosphonates, sulfonic acids, phosphonic acids and mixtures thereof.

33. A method in accordance with Claim 32, wherein said proton conductive material is selected from the group consisting of ligno-sulfonic acid, *para*-toluene sulfonic acid and mixtures thereof.

34. A method in accordance with Claim 30, wherein said electron conductive material comprises at least one electropolymerized ionomer.

35. A method in accordance with Claim 34, wherein said ionomer is selected from the group consisting of aniline, pyrrole, azulene and mixtures thereof.

36. A method in accordance with Claim 30, wherein said electron conductive material comprises a grafted polymer.

37. A method in accordance with Claim 36, wherein said grafted polymer comprises polyaniline grafted to lignin.

38. A method in accordance with Claim 36, wherein said electron conductive material is grafted with a proton conductive material.

39. A method in accordance with Claim 30, wherein said electron conductive material is at least one of sulfonated and phosphonated.